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Processing of Verbal Morphology in Norwegian Speakers with Alzheimer's Disease (AD)

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This investigation is a pilot study aiming to identify suitable tools for assessing the linguistic competence of AD patients, compared to aphasics and normal elderly controls. A picture test eliciting past tense forms of Norwegian verbs, originally developed for testing children's development of past tense inflection, has previously also been used for SLI children, adults under time pressure, second language learners, and Broca's aphasics (BA). Different error patterns have emerged for these groups, mainly related to the inflectional forms of the verbs. AD patients showed few errors of form, but some chose the past tense form of a different verb semantically related to the target verb. Furthermore, they easily strayed away from the test words, associating with other words. Our results indicate that the AD patients differ from the BA patients in having a semantic and not an inflectional problem. The age matched controls had no problems performing the test.

Introduction

The present investigation explores the capacity for morphological processing of Norwegian verbs in elderly patients with mild dementia of the Alzheimer's type (AD). The test used was originally developed for testing children's development of past tense inflection (Ragnarsdóttir, Simonsen & Plunkett, 1999), and is a picture elicitation task where the subject is shown a picture of someone performing an action. The experimenter says: "This is a boy who VERBS. He is VERBING. He did the same thing yesterday. What did he do yesterday?" And the subject is supposed to fill in the past tense form of the verb: "He VERBED (or, for instance: VARB)".

The test has been used with several different subject groups: typically developing children at 4, 6, and 8 years (Ragnarsdóttir, Simonsen & Plunkett, 1999; Simonsen, 2001), SLI children (Bjerkan, 2000), adults under time pressure (Simonsen & Bjerkan, 1998), Russian learners of Norwegian as a second language (Tkatchenko, 2003), and three persons with Broca's aphasia (see Simonsen & Lind, 2002 for data from one of these). Different error patterns emerge for these different subject groups, both concerning number and types of errors made. The children, in particular the youngest ones, make many errors of inflection – mainly different kinds of overgeneralization errors. Some SLI children also make so-called 'wrong verb' errors, using the past tense of a different but semantically related verb, (e.g. *så* 'saw' instead of *tittet* 'looked'.) Adults under time pressure make errors of both types, but much fewer errors. L2 learners make many errors, and overgeneralization errors are dominant; they also make a few 'wrong verb' errors, but those are all phonetically similar to the target verb forms, and not semantically related.

The three subjects with Broca's aphasia (BA) hardly use any verb inflections in their spontaneous speech. On the test, however, they all demonstrate an ability to inflect verbs. Given enough time to respond, they manage to produce between 20 and 50 out of 60 correct past tense forms. Each

of them have different dominant error types: BA 1, who only has 10 errors, produces a wrong inflection (infinitive, present tense, or past participle), or makes 'wrong verb' errors semantically and/or phonetically similar to the target. When provided with the correct forms, however, he ends up with a correct set of verb forms (Simonsen & Lind, 2001). BA 2, with 20 errors, has overgeneralization of one of the regular verb inflections as his dominant error type – this inflection seems to function as a default past tense inflection for him. BA 3, with 40 errors, tends to repeat the verb in the infinitive or present tense form, or to give no answer. He also makes overgeneralization errors, which seem to be partly phonologically motivated. In sum, the test results indicate that subjects with BA have a problem with verbal inflection, but that they perform much better on the test than in their spontaneous speech.

How would we expect AD patients to perform on a test like this? AD patients have a more global neurodegenerative impairment than patients with Broca's aphasia. There is no indication in the spontaneous speech of the patients with mild AD that they have a problem with verbal inflection. However, since there is general agreement that AD patients have a semantic impairment, we would expect this to appear in a formal test situation. There is discussion in the literature as to whether the impairment is in the structure of semantic memory, or whether the problem is one of access and retrieval of the contents of semantic memory (Chenery, 1996). It has been suggested that at least in the earlier stages of AD, the problem is mainly of a procedural nature, but that this may change with the severity of the illness (Chenery, Murdoch & Ingram, 1996). Furthermore, the semantic processing problems may be related to degree of automaticity of retrieval: AD patients have problems with more controlled processing, while more automatic processing is retained (Bates, Harris, Marchman, Wulfeck & Kritchevsky, 1995; Bell & Chenery, 2001).

Experiment

Subjects

The experiment involved two subject groups, a group of 10 AD patients and a group of 10 normal age matched controls. The patients were over sixty-five years of age, had been diagnosed at least three years previously, and suffered from mild to moderate and relatively slowly progressing AD. They had been assessed clinically at The Norwegian Centre for Dementia Research, Ullevaal University Hospital, Oslo. Single Photon Emission Computed Tomography (SPECT) had been performed on all patients. They had all been treated with reversible cholinesterase inhibitors. The sample characteristics of the AD patients are shown in table 1.

Verbs

The test consists of 60 verbs, chosen to represent the main verb classes of Norwegian. Norwegian is similar to English in having a clear distinction between a large group of weak (regular) verbs and a small group of strong (irregular) verbs, but differs from English in having two subclasses of weak verbs, one of which is larger than the other. (For more information about Norwegian verb classes see Endresen & Simonsen, 2001). The verbs were matched for token frequency, with approximately the same number of high and low frequency verbs in each verb class.

Table 1
Sample characteristics of the AD patients

Patient	Sex	Age	MMSE	OLT	Clock	TMT-A	TMT-B	Verb test
1	F	75	22	17	—	55	95	9
2	F	75	19	13	0	60	cannot	8
3	F	82	23	17	4	46	cannot	0
4	F	79	25	25	4	45	100	0
5	M	73	28	26	7	47	119	0
6	M	72	24	18	5	47	117	8
7	F	76	27	24	4	39	—	2
8	F	76	20	9	5	60	cannot	0
9	F	68	19	15	0	—	—	2
10	F	75	20	10	6	83	cannot	1

Educational level: patients 4 and 10: university education, the other patients: between 7-10 years of education

MMSE=Mini Mental state Examination (max score 30, best)
OLT=Object Learning Test (max score 70, best)
Clock drawing test (max score 7, best)
TMT-A=Trail Making Test version A (short time is best)
TMT-B=Trail Making Test version B (short time is best)
Verb test=Past tense inflection test (score above 3=impaired performance)

Procedure

The subjects were presented with pictures depicting actions as illustrated above, and the infinitive form of the verb was presented in writing below the picture. The oral cue was given by the examiner in the present tense, and the subjects were given the time they needed to respond with the past tense of the verb.

Results and discussion

The control subjects made at the most three errors on the 60 verbs, and half of the controls made no errors. The errors were mostly overgeneralizations – but a wrong verb error (*så* 'saw' instead of *tittet* 'looked', cf. above) occurred in two subjects.

Among the AD subjects, 3 made no errors, and 4 made 1-2 errors – thus matching the performance of the normal controls. The remaining three AD subjects had more problems: AD 1 made 9 errors, AD 2 made 8 errors, and AD 6 made 8 errors. AD 1 and AD 2 both had low cognitive test scores, and nearly all their errors were wrong verbs, semantically related to the target. Several were near synonyms (*skreik* 'screamed' for *gråt* 'cried'; *spiste* 'ate' for *smakte* 'tasted', etc.), a few were antonyms (*var varme* 'were hot' for *frøs* 'froze', *slapp* 'let go' for *holdt* 'held'), and some seemed to be triggered by the picture itself (*sovnet* 'fell asleep' for *tittet* 'looked' – the picture showing someone looking under the bed). More often than not, the chosen verb was more frequent, and/or of a more colloquial form, than the target verb. AD 6 had higher cognitive test scores, and his errors were also different: 4 were overgeneralizations, only 1 was a

semantically related wrong verb form, while 3 were perseverations – he responded with the target form for the previous verb in the test. His deviant performance may possibly be related to a more frontal lesion. He also showed a repetitious verbal behaviour in his spontaneous speech. Four of the AD patients scored well on the test in spite of their low cognitive test scores: AD 3, AD 8, AD 9 and AD 10. For AD 10 a possible explanation may be her high level of education – she is one of two patients with a university education. However, it is evident that the performance on this test is not in itself a stable indicator of cognitive impairment. On the other hand, the performance of the AD patients during the test was often different from that of the BA patients and the normal controls, in spite of their not making many errors. Most of the AD patients made slightly irrelevant comments about the pictures in the test items (like saying "oh look at this poor child" for the picture related to 'cry') and often made verbal detours before reaching their answer. The other subject groups either gave a direct answer or, in the case of the BA patients, remained silent until further prompting.

Comparing the performance of the AD patients to the BA patients, we see that they clearly differ. The BA patients all have problems with verb inflection, to varying degrees, using different strategies to cope with this problem. Most of these mild AD patients have no problems with inflection per se – the impairments they show are of a semantic nature. The errors they make indicate that they may have problems with accessing the right verb form, choosing instead a form which is semantically related to the target in one way or another – often a more frequent form, and/or a form that is closer to their colloquial speech. Associations may also be triggered by the test picture. All these error types are indicative of a semantic access impairment where automatic processes take precedence.

Conclusions

The verbal inflection test seems to distinguish clearly between BA patients and AD patients, but it does not always distinguish a patient with mild AD from a normal elderly person. However, as part of a test battery for identifying possible linguistic deficits in elderly people, it may be of value as a clinical tool.

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